TECHNICAL NOTES

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SUBJECT: CPA - IMPACTS OF CONSERVATION TILLAGE AND CROP RESIDUE ON SOIL LOSS, INFILTRATION, CUMULATIVE WATER INTAKE, AND CROP YIELDS ON FURROW IRRIGATED CROPLANDS

The attached Idaho Technical Note Agronomy No. 44 provides useful information from up-to-date research.

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IMPACTS OF CONSERVATION TILLAGE AND CROP RESIDUE ON SOIL LOSS, INFILTRATION, CUMULATIVE WATER INTAKE, AND CROP YIELDS ON FURROW IRRIGATED CROPLANDS

For over 40 years, researchers have been developing conservation tillage and no-till techniques for crop production systems. Most of this work has been on croplands where natural precipitation provides all of the moisture used by growing crops.

During the past several years, conservation tillage research has expanded to irrigated croplands. This paper reviews some of the research on the impacts conservation tillage and straw spreading has on irrigation induced soil losses, water infiltration, total cumulative water intake, and crop yields on surface irrigated croplands.

Irrigation Induced Soil Erosion

Irrigation induced soil erosion is a serious problem on irrigated croplands where water is delivered to crops by running it over the soil surface. Energy from water moving over the soil loosens soil particles and transports them downslope to a point where energy decreases and deposition occurs, or runoff carries soil from the field.

The amount of soil loss occurring on surface irrigated cropland had not been well recognized until the middle to late 1970's when surface water quality became a concern. Research by Dr. David Carter and others at the Snake River Conservation Research Center near Kimberly, Idaho (1) found soils losses from furrow irrigated croplands to be much greater than expected. They found average sediment soil losses ranging from 28 to 77 tons per acre per year, where row crops were grown on slopes greater than 3%.

Carter's research encouraged further study of the problems associated with irrigation induced soil losses. In 1985, Carter etal (2) reported on the impact soil erosion was having on soil depth and crop yields near Kimberly, Idaho. Their research on an area covering 14 farms, showed 21 percent of the croplands in the study area had lost approximately 15 inches of topsoil during the

80-year period since first being farmed and irrigated. Seventy percent of the fields in the study area had been eroded sufficiently to expose light-colored subsoils on the soil surface. This light-colored subsoil was exposed on the upper 30% of most fields. Original topsoil depth over the light-colored topsoil was approximately 15 inches.

Crop yields on the exposed subsoils were from 25 to 30 percent less than areas of the field where subsoils were not exposed. Applying additional fertilizers did not restore soil productivity on the eroded areas.

Erosion Control

Using crop residue to reduce irrigation induced soil erosion was studied by Aarstad and Miller at Prosser, Washington in 1977-78. (3). They found corn residues in irrigation furrows all but eliminated soil erosion. In 1981, they (4) reported on additional research where varying amounts of crop residue were applied. Residue rates between 250-2000 pounds per acre were applied to the irrigation furrows. All residue rates reduced soil losses by at least 83 percent.

Mel Brown (5) on field bean trials, hand spread one pound of straw per 100 feet of irrigation furrow. Sediment yield from the non-strawed row segments with larger irrigation streams was 2.48 times higher than on the strawed rows. Where low irrigation flows were used, sediment yield was 23.6 times greater on the non-strawed rows. Using variable straw rates of 0.6 mt/ha, 1.2 mt/ha and 2.2 mt/ha, Berg (6) found sediment yields were reduced from 30 to 100 percent in the straw-treated furrows, compared to furrows without straw. Heavy straw rates produced the greatest reduction in sediment yield.

Monitoring studies on the Rock Creek Rural Clear Water Project (Idaho) (1) showed fields under conservation tillage had an average of 56% less sediment yield than conventionally tilled fields. Where no-till was used, sediment yields were reduced by approximately 99%.

Water Infiltration

In the early 1980's, researchers at the University of Nebraska's south central station (7) compared various types of tillage systems. They found net water infiltration was 74 percent greater when reduced tillage was used compared to conventional tillage systems.

Brown (5) found furrows with no straw, infiltrated 44% of the total applied irrigation water. Strawed furrows infiltrated 66% of the total irrigation water applied on high irrigation flows (15.0 liters/minute). Brown also observed the lateral wetting front on the strawed irrigation furrows moved approximately twice as fast as that of the non-strawed furrows. The normal irrigation set time on unstrawed beans at Kimberly is 12 hours. Where straw had been applied to the furrow, he found the plant root zones were completely filled in 6 hours.

Berg's (6) study on sloping furrow irrigated cropland, showed irrigation water infiltration on the strawed furrow was 50% higher than on the no-straw furrows.

Researchers at the University of Oregon's Malheur Research Station (8) spread 790 pounds of wheat straw per acre on furrow-irrigated potatoes. They found strawed furrows absorbed an average of 75% of applied irrigation water in the first irrigation and an average of 44 percent of applied irrigation water during the second irrigation. On the non-strawed furrows, 46% of the total applied water was infiltrated during the first irrigation and 31% during the second irrigation. Straw in furrows increased infiltration an average of 26% on the first irrigation and 13% on the second irrigation.

Miller and Aarstad at Prosser (4) measured infiltration on furrow-irrigated croplands with varying rates of straw cover. Residue rates varied from 250 to 2000 pounds per acre. Infiltration increased approximately 50-60 percent with the addition of 150-750 pounds of straw. Where higher rates had been applied, infiltration increased to over 2 times that of the unstrawed furrows.

The authors' personal observations show many producers tend to over irrigate fields with residue on the soil surface because of the increase in infiltration. Irrigation set time needs to be reduced to meet the new water intake rates or nitrogen leaching will occur.

Cumulative Intake

The Prosser (4) studies measured total cumulative water intake during five 24-hour irrigations over a two-year period. They found total cumulative water intake into the soil on the strawed furrows, to be an average of 2.48 times greater than where straw was not applied.

Crop Yields

When Brown (5) measured the bean production from his study, he harvested an average of 2622 pounds of beans from the non-strawed furrows and an average of 3484 pounds of beans from the strawed furrows. Yields on the strawed furrows averaged 33 percent greater where straw had been placed in the irrigation furrow. Berg experienced yield increases ranging from 7-16 percent.

Studies on sugar beets at Malheur, Oregon (9) showed yields of 37.5 tons per acre on strawed furrows and 30.1 tons per acre on non-strawed furrows. Harvested sugar was estimated to be 10,020 pounds per acre from the strawed furrows and 7,540 pounds per acre from non-strawed furrows. This represents an increase of 33% in harvestable sugar per acre where furrows were strawed.

Summary

Irrigation induced soil erosion can be very severe on furrow irrigated croplands. Loss of topsoil can reduce the future crop yield potential of surface irrigated croplands. When topsoil has been eroded to expose subsoils, crop yields are decreased from 15-30% below soils with original top soil depths.

Using conservation tillage to maintain straws on the soil surface, or spreading straw on the irrigation furrow can reduce soil loss by 50 to 99 percent, depending on the amount of straw. Straw in the irrigation furrows increases water infiltration by approximately 50 percent, increases movement of the wetting front and the total cumulative amount of water moving into the soil. This improves soil moisture condition for crops. These improvements in soil moisture condition have potential to increase crop yields. Adjustments in irrigation set time is required to protect the field from excessive leaching.

References:

1. Carter, D.L., Rock Creek Rural Clean Water Program Project, Annual Report, 1987.

2. Carter, D.L., R.D. Berg and B.J. Sanders, 1985, The Effect of Furrow Erosion on Crop Productivity, Soil Science Society of America Journal, Vol. 49, No. 1. Jan-Feb.

3. Aarstad, J.S. and David E. Miller, 1981, Corn Residue Management to Reduce Soil Erosion in Irrigated Furrows. J. Soil and Water Cons. 33: 289-291.

4. Aarstad, J.S. and David E. Miller, 1981, Effects of Small Amounts of Residue on Furrow Erosion. Soil Sci. Soc. Am. J. 45: 116-118.

5. Brown, M.J. Effect of Grain Straw and Furrow Irrigation Stream Size on Soil Erosion and Infiltration 1985, d. Soil and Water Cons. July & Aug., 1985, Vol. 40. Number 4.

6. Berg, R.D., 1984. Straw Residue to Control Furrow Erosion on Sloping Irrigated Cropland, J. Soil and Water Cons., Vol. 39, Number 1, Jan-Feb 1984.

7. Eisenhauer, Dean E., Elbert C. Dickey, Paul E. Fischbach, Kenneth D. Frank, 1982, Influence of Reduced Tillage on Furrow Irrigation Infiltration, Am. Soc. Ag. Eng., Chicago, Il, Dec. 14-17, 1982.

8. Shock, Clinton, H. Futter, R. Perry, J. Swisher, J. Hobson, Effects of Straw Mulch and Irrigation Rate on Soil Loss and Runoff, 1985. Malheur Agricultural Experiment Station unpublished report.

9. Shock, Clinton C. and Charles Stanger, 1986, Observations on the Effect of Straw Mulch on Sugar Beet Stress and Productivity. Unpublished report, Malheur Experiment Station.